Small Business Innovation Research/Small Business Tech Transfer

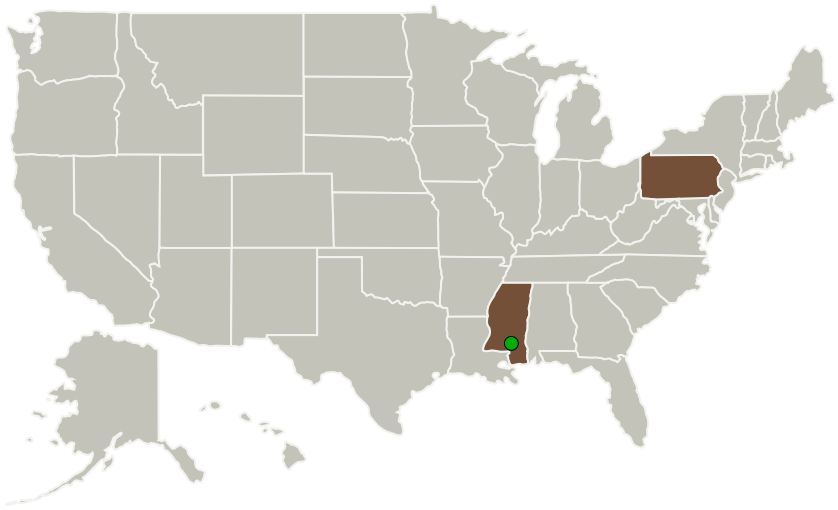
Waste Heat Recovery by Thermo-Radiative Cell for Space Applications, Phase I

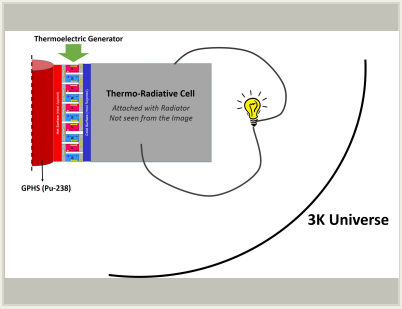
Completed Technology Project (2017 - 2018)

Project Introduction

In response to the NASA STTR solicitation topic T3.01, "Energy Harvesting, Transformation and Multifunctional Power Dissemination", Advanced Cooling Technologies, Inc. (ACT) and Carnegie Mellon University (CMU) propose to develop a thermo-radiative cell to harvest energy from waste heat, for example, from radiators. Currently NASA's Top Technical Challenge is the need to "increase available power". Additionally, NASA has a Grand Challenge as "Affordable and Abundant Power" for NASA mission activities. The thermo-radiative cell technology uses semiconductor p-n junctions, similar to the photovoltaic cell but with smaller band gap semiconductor, to convert heat to electricity. This technology makes use of the extremely cold dark universe (~3K) as the natural heat sink and low-grade waste heat (~50-100°C) as the heat source. The imbalance of the thermal radiation emitted and absorbed by the cell will cause the imbalance of the charge carrier motion in the p-n junction, i.e., generating electrical power. The overall technical objective of Phase I and Phase II projects is to develop a thermo-radiative cell system that can generate practically usable power as supplementary power for the electronics on space vehicles, platforms or habitats. During Phase I, ACT will fabricate a cryogenic system to investigate the performance the thermo-radiative cell made of commercial available InSb, HgCdZnTe, PbSe, or InAs wafers. The cryogenic system will use liquid nitrogen to create a stable low temperature environment. Performance investigation includes the power density and energy efficiency at different heat source temperatures for the non-optimized cell material component and structure in Phase I.

Primary U.S. Work Locations and Key Partners





Waste Heat Recovery by Thermo-Radiative Cell for Space Applications, Phase I Briefing Chart Image

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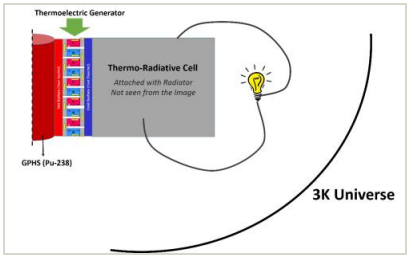
Organizations Performing Work	Role	Type	Location
Advanced Cooling Technologies, Inc.	Lead Organization	Industry	Lancaster, Pennsylvania
Carnegie Mellon University	Supporting Organization	Academia	Pittsburgh, Pennsylvania
Stennis Space Center(SSC)	Supporting Organization	NASA Center	Stennis Space Center, Mississippi

Primary U.S. Work Locations	
Mississippi	Pennsylvania

Images



Briefing Chart Image
Waste Heat Recovery by Thermo-Radiative Cell for Space Applications, Phase I Briefing Chart Image
(https://techport.nasa.gov/image/132576)

Organizational Responsibility

Responsible Mission Directorate:
Space Technology Mission Directorate (STMD)

Lead Organization:
Advanced Cooling Technologies, Inc.

Responsible Program:
Small Business Innovation Research/Small Business Tech Transfer

Project Management

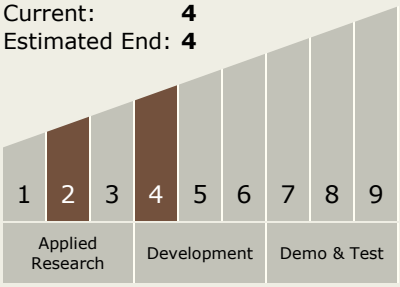
Program Director:
Jason L Kessler

Program Manager:
Carlos Torrez

Principal Investigator:
Jianjian Wang

Technology Maturity (TRL)

Start: **2**
Current: **4**
Estimated End: **4**



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Technology Areas

Primary:

- TX03 Aerospace Power and Energy Storage
  - TX03.1 Power Generation and Energy Conversion
    - TX03.1.4 Dynamic Energy Conversion

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System